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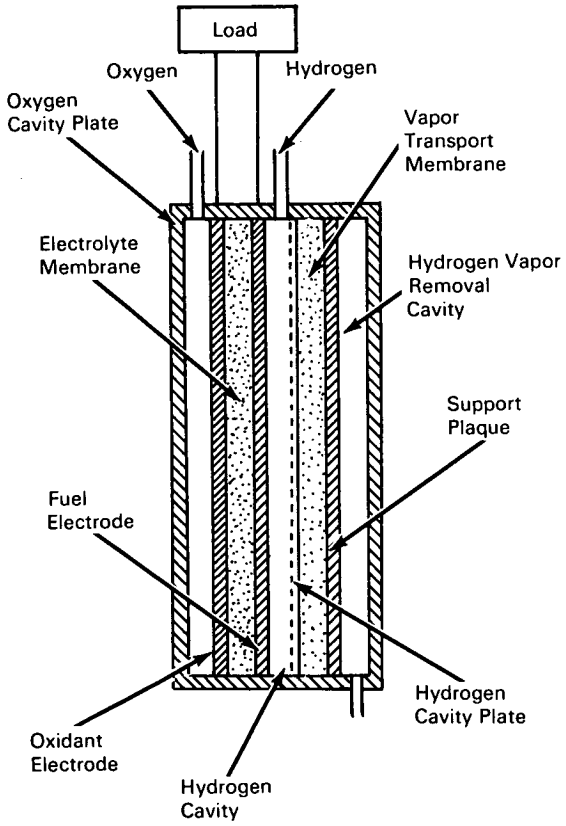
NASA TECH BRIEF

Reaction Heat Used in Static Water Removal From Fuel Cells



The problem: In hydrogen–oxygen fuel cells, more water is formed at the hydrogen fuel electrode than is needed for cell reactions. If not removed as rapidly as formed, this excess water causes electrode flooding, a decrease in cell output, and ultimate cell failure. In the past, many arrangements of pumps and condensers have been used to remove this water with varying results. Such equipment requires sufficient power to seriously penalize the high efficiency of the fuel cell.

The solution: A system that uses a portion of the heat inherent in the fuel cell current generation reaction to transform excess water into water vapor and cause it to be exhausted from the cell by means of a porous vapor transport membrane adjoining a vapor removal cavity maintained at low pressure.

How it's done: As an electrical load is applied to the fuel cell, oxygen enters the oxygen cavity and

(continued overleaf)

hydrogen enters the hydrogen cavity and come in contact with the electrolyte in the electrolyte membrane through the oxidant and fuel electrodes, respectively. The gases have relatively free access to the electrolyte membrane for production of the required chemical reaction. The oxygen at the oxidant electrode reacts with the electrolyte (an aqueous solution of potassium hydroxide) and is electrochemically reduced to hydroxyl ions. The hydrogen reacts with the hydroxyl ions and is electrochemically oxidized to water, releasing electrons to the load circuit. For every unit of hydrogen oxidized, two units of water are formed at the fuel electrode. One unit of this water migrates into the electrolyte membrane to replenish the water used in the oxygen reduction. The other unit of water is waste product and must be removed from the cell.

In both of these reactions, heat is produced. Some of this heat is absorbed by the product water formed at the fuel electrode and transforms the water to a vapor. This vapor diffuses into and through the vapor transport membrane where heat of the cell causes evaporation of the water from the vapor transport membrane into the vapor removal cavity. The vapor removal cavity, through the water exhaust line, is maintained at a suitable low pressure so that the water is removed from the cell structure at a rate consistent with its generation at the fuel electrode.

Notes:

1. The requirement for fins or other cooling media on the cell is minimized by use of some of the generated heat in removal of the waste water.
2. This invention provides a compact fuel cell having high energy-to-weight and energy-to-volume ratios and requiring a minimum of auxiliary equipment.

Patent status: Title to this invention has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)), to the Allis-Chalmers Manufacturing Company, Box 512, Milwaukee, Wisconsin, 53201.

Source: John L. Platner of
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